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The Distant Geomagnetic Field.

5. Long-Period Oscillations

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Abstract. Long-period magnetic oscillations ($\geq$100 seconds) seen on the Pioneer 1 flight are discussed. The indication is that these oscillations are comparable in scale to the magnetosphere and are primarily radial, that is, are contained in geomagnetic meridian planes. The energy densities agree with the fluctuation level in the free-stream solar wind and suggest the excitation mechanism discussed by Dessler based on a fluctuating solar wind pressure.

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Previous papers in this series on machine analyses of Pioneer 1 data have examined short-period oscillations, shocklike behavior, and manifestations of instability in the fringe regions of the earth's magnetic field. This paper is concerned with certain variations of period $\geq$100 seconds in the phase of the returned signal from the search coil magnetometer used in the experiment. The data format, nomenclature, and orbital identifying code follow that used previously. For these matters, as well as the instrumentation and data routine, the reader is referred to the earlier papers [*Sonett et al.*, 1962; *Sonett*, 1963*a*, *b*; *Sonett and Abrams*, 1963].

The signal processing makes use of the mean phase time rate of change, which corresponds closely to the spin angular frequency of the spacecraft. For the magnetic signal the mean phase time rate was obtained by averaging the phase time rate $\dot{\psi}$ over each swath of data, using this to yield a mean cumulative phase, and subtracting it from the instantaneous cumulative phase at a time t. The residue, after subtraction, consists of fluctuations in phase. The process of taking differences between the mean and the instantaneous phase is equivalent to a coordinate rotation through the angle φ as shown in Figure 1, where the cumulative phase is plotted against time. Thus the slope $\tan^{-1} \varphi$ is the mean time rate of change of phase, or the frequency. Subtraction of the mean rate from the record leaves the residue. Truncation of the hydromagnetic period should not be an important effect in this subtraction.

The data discussed follow the coding of the first paper of the series about the magnetosphere from 3.7 to 7 Re. For the configurational aspects of this material, the reader is referred to the geometry discussion there. In the simplified viewpoint appropriate here, the oscillations in phase may be taken to be essentially normal to the quiescent direction of the geomagnetic field and contained in the magnetic meridian planes. Thus they appear to be either radial in the sense of a spherical geomagnetic coordinate system as contrasted to torsional or the projection onto the local geomagnetic meridian plane of an elliptically polarized wave. The experiment is not deemed sufficiently accurate to rule between these alternatives. (In principle, an elliptically polarized wave should display sinusoidal amplitude and phase disturbances in the magnetometer signal and with a specific phase relation between the two signals.)

The swaths of data shown correspond to certain groups discussed in the first paper of this series. Both 100- and 200-second swaths are shown in Figures 2, 3, 4, and 5. The times and geocentric radii are given for convenience in Table 1. Figure 2 displays the only complete cycle noted. The asymmetry in the two half-cycles of this figure is indicative of a general irregularity in frequency which, together with the

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